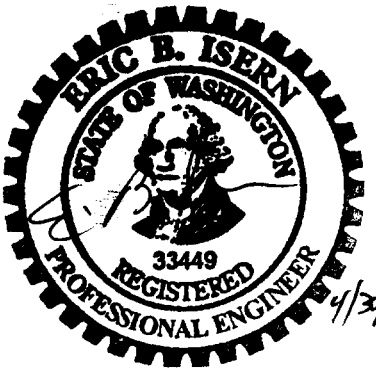
RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

Air Displacement Slurry Pumps



4/30/04

EXPIRES: 07/28/05

Content applicable to ALARA? ☒ Yes ☐ No

ADR No.
N/A

Rev

Quality Designator
CM
DOE Contract No. DE-AC27-01RV14136

NOTE: Contents of this document are Dangerous Waste Permit affecting.

This bound document contains 14 pages including the cover page

REV	DATE	REASON FOR REVISION	BY	CHECK	REVIEW	QA	APEM/DEM
0	4/30/04	Issued for Permitting	M. Seed		N/A	N/A	

SPECIFICATION No. 24590-WTP-3PS-M000-TP001 **Rev** 0

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Contents

Appendices

1 Scope

1.1 Project Description and Location

A. This specification provides the criteria for design of the Air Displacement Slurry (ADS) pumps for the River Protection Project – Waste Treatment Plant (RPP-WTP) at the Hanford site of the Department of Energy. The ADS pumps will be utilized for both the High Level Waste (HLW) and Low Activity Waste (LAW) melter feed systems. The design will be similar for the HLW and LAW but may vary in dimensions, overall length, flange type and cycling to meet the contract throughput requirements, which are different for each.

B. Deleted.

C. The Subcontractor shall base design on the information provided in this specification, the referenced documents herein, and the contract documents.

D. Subcontractor shall provide submittals as required by section 5 of this specification.

E. The design of the ADS pumps shall be coordinated with the design of the melters (Reference 2.2E for LAW and Reference 2.2F for HLW) to meet the required throughput values.

1.2 Definitions

A. Actuator Assembly – A separate subassembly that uses an air cylinder to activate the poppet. The actuator is a double acting cylinder requiring two air connections.

B. Air Displacement Slurry (ADS) Pump– A mechanical device that uses air to push slurry into the melter at controlled rates.

C. Contractor – Bechtel National, Inc.

D. Poppet – The moving part of a double seal valve inside the ADS pump.

E. Subcontractor – Duratek, Inc.

F. Deleted

G. Vent Valve Assembly – A separate subassembly that uses an air actuated 3-way valve to vent the pump chamber or to supply air to chamber for moving slurry.

1.3 Acronyms

Acronyms used in this specification section include:

ADS	Air Displacement Slurry
DIW	Demineralized Water

HLW	High Level Waste
ISA	Instrument Service Air
LAW	Low Activity Waste
LFP	LAW Melter Feed Process System
HFP	HLW Melter Feed Process System
PSA	Plant Service Air
QAP	Quality Assurance Program

2 Applicable Documents

2.1 Referenced Codes and Industry Standards

Note: All Codes and Industry Standards shall be to the latest version/year/edition in force at the time of issue of the specification unless specifically identified below.

A. American Society of Mechanical Engineers ASME B31.3, 1996, *Chemical Plant and Petroleum Refinery Piping*

B. American Institute of Steel Construction, AISC MO16-89, *Manual of Steel Construction – Allowable Stress Design, 9th Edition*

C. American Institute of Steel Construction, ANSI/AISC N690-1994, *Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities*

D. American Society of Mechanical Engineers ASME Section VIII, Division 1, *Rules for Construction of Pressure Vessels*

E. Quality Standard for Instrument Air, ANSI/ISA-S7.0.01, 1996

F. American Society of Mechanical Engineers, ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications (1989).*

G. American Society of Mechanical Engineers, ASME NQA-2a, Part 2.7, *Quality Assurance Requirements of Computer Software for Nuclear Facility Applications (1990).*

2.2 Reference Documents

A. Deleted

B. 24590-WTP-3PS-FB01-T0001, *Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment*

C. 24590-WTP-3PS-SS90-T0001, *Engineering Specification for Seismic Qualification of Seismic Category I & II Equipment*

D. 24590-WTP-DC-ST-01-001, *Structural Design Criteria*

E. 24590-LAW-3PS-AE00-T0001, *Performance Specification for Low Activity Waste Melters*

F. 24590-HLW-3PS-AE00-T0001, *Performance Specification for High Level Waste Melter*

G. Statement of Work for Subcontract 24590-CM-SRA-HM00-00001, *Modeling and Design of Melters*

H. Deleted

I. 24590-WTP-3PS-G000-T0001, *Supplier Quality Assurance Program Requirements*

J. DOE-RL-92-36, *Hanford Site Hoisting and Rigging Manual*

K. 24590-WTP-TSP-RT-01-004, *Development of Simulants to Support Mixing Tests for High Level Waste and Low Activity Waste*

L. VSL-01R3520-1, *Final Report, Physical and Rheological Properties of Waste Simulants and Melter Feed for RPP-WTP-LAW Vitrification*

M. VSL-00R2520-1, *Final Report, Physical and Rheological Properties of Waste Simulants and Melter Feeds for RPP-WTP-HLW Vitrification*

3 Design Requirements

Note: The contents of this specification contain requirements for the design of both the LAW and HLW ADS pumps. If there is a specific requirement related to either the LAW or HLW pumps it will be designated as such. If no specific designation exists, the requirement applies to both LAW and HLW ADS pumps.

3.1 Functional Description

Waste concentrates (High Level and Low Activity) and dry glass formers are blended together in a feed preparation vessel to form a waste slurry. The resulting slurry is transferred to a feed vessel that supplies the melter. The ADS pumps are used to transfer the waste slurry from the feed vessel into the melter. The lower portion (housing and body) of the ADS pumps is submerged in the feed vessel while the upper portion (actuator assembly and vent valve) are positioned on the outside of the feed vessel. The assembly is connected to the feed vessel via a flange connection. HLW ADS pumps are maintained remotely via a crane hook and power manipulator. Fabrication must be to stringent tolerances to allow interchangeability.

3.2 Work Included

The Subcontractor is responsible for the design of the ADS pumps for both HLW and LAW. Designs shall include, but not be limited to: pump body, screen, poppet, lift rod, pump actuator assembly, vent valve assembly, remote lifting device (HLW), lifting device (LAW) and pump discharge line or discharge attachment point. Pump designs shall also include the mating flange connection to the feed vessel from which the pump is suspended, and all pump services and discharge line pass through. The controls for the ADS pumps will be designed as part of the deliverable requirements of Reference 2.2E and 2.2F and will not be included as a requirement

in this specification. Coordinate with contractor to define mating flange and discharge line configuration and connection requirements.

3.3 Performance Requirements

A. The ADS pumps shall be designed to support the following glass production rates:

1. LAW - 15 metric tons per day per melter.
2. HLW - 3.0 metric tons per day.

B. ADS pumps shall be designed with twice the capacity as stated in 3.3A to facilitate melter start up from an idle condition.

C. Deleted.

D. The design life of the ADS pump, pump vent assembly and pump actuator assembly shall be 5 years.

3.4 ADS Pump Functional Requirements

A. Each LAW melter shall be fed with six (6) ADS feed pumps (total) or two (2) feed pumps per melter zone. The ADS pumps shall be sized/designed so that one pump can supply each zone of the melter in the event the other pump in the zone is out of service. (Note: the LAW melters are designed with three separate zones, two feed nozzles per zone).

B. The HLW melter shall be fed with two ADS pumps, both pumps must be operating for melter operations.

C. Deleted.

D. To ensure continuous flow to each nozzle with a reduced likelihood of plugging, there shall be one feed pump per melter feed nozzle.

E. ADS pumps shall be capable of transferring a known volume of slurry based on the final pump chamber size.

F. The ADS pumps (and subsequent feed lines and nozzles) shall be designed for flushing with water on a periodic basis to clear any residual material in the feed lines and reduce the potential for plugging.

G. Inlet screens shall be provided to protect the pump and feed lines from large solids or foreign material. The screen shall be sized to prevent passage of the solids that can jam in the clearance between the poppet and the pump body.

H. ADS pumps shall be designed for back flushing the inlet screen with water on a periodic basis to remove any solids buildup on the screen.

I. Deleted.

J. The ADS pumps, actuator assembly, and vent valve assembly shall be designed with appropriate lifting bails. (Appendix A and Appendix B).

K. Air supply that contacts the feed slurry (motive air) shall be vented to the feed vessel.

L. The pump discharge line (external to the feed vessel), actuator assembly, and vent valve assembly shall be designed so that each can be replaced without having to remove the ADS pump from the feed vessel.

3.5 Technical Requirements

A. The ADS pumps shall be designed to meet Ref. 2.1A, Category D designation for all fluid containing components with the exception of the pump discharge line which shall be designed to meet Reference 2.1A, Category M designation. The flange connection to the feed vessels shall be designed in accordance with Reference 2.1D with design pressures defined in Appendix A and Appendix B.

B. The pump discharge line shall be designed with butt weld fittings only to eliminate potential crevice corrosion unless approved by the contractor. All changes in direction shall be via pipe/tube bends with minimum 5 diameter bend radius.

C. The flow velocity shall be high enough to avoid settling of solids in the feed lines. Target velocities are between 4 feet per second to 8 feet per second for all throughput requirements.

D. The ADS pump fluid carrying components shall be designed for a maximum pressure of 150 PSIG.

E. Reference Appendix A and Appendix B for the vessel operating and design pressure and temperature conditions.

F. Structural design shall be per the Allowable Stress Design method in accordance with the provisions of Reference 2.1C for the HLW ADS pumps and Reference 2.1B for the LAW ADS pumps.

G. For the purposes of seismic analysis, the HLW and LAW ADS pumps shall be designed as follows::

1. HLW – shall be in accordance with Reference 2.2C for SC-II equipment.
2. LAW – shall be in accordance with Reference 2.2B, for SC-III equipment.

H. Loadings

1. Static Loading: Design shall include the combined weight of the pump structure, poppet, flange, vent valve actuator assembly, pump actuator assembly, pump discharge line and weight associated with maximum slurry volume.
2. Dynamic Loading:
   a. Design shall consider resonant frequency with the agitator blades in the feed vessels. Agitator design data is provided in Appendix A and Appendix B.
   b. Dynamic effects from pumping forces on the pump column shall be evaluated.
   c. High cycle fatigue shall be considered.
3. Seismic Loads: Design loads shall be in accordance with Reference 2.2B for SC-III equipment (LAW ADS pumps) and in accordance with Reference 2.2C for SC-II equipment (HLW ADS pumps).
4. Other Loads to Consider:
   a. Piping/Jumper loads during normal operations.

b. Lifting attachment locations for movement of the pump assembly via the crane. Attachment point shall be designed to accommodate 5° vertical angularity during vertical pump lifts.
c. The pump must support itself while being lifted from one end, from the horizontal position to vertical.
d. Lifting bails and attachments must be designed for a minimum safety factor of 3, based on material yield strength, or safety factor of 5 based on material ultimate strength per Reference 2.2J.

5. Load combinations shall be in accordance with Reference 2.2D.

6. Coordinate between Contractor and Subcontractor for additional restraining mechanisms for the pump body to increase the natural frequency if dynamic effects warrant the addition.

I. Deflection of the ADS pumps shall be limited to avoid interaction with agitators as specified in Appendix A and Appendix B.

J. The flange connection for the feed vessel flange shall be to the design requirements of the melter feed vessels, for pressure, temperature, vacuum rating, and material compatibility and toleranced to allow remote changeout and interchangeability. See Appendix A and Appendix B.

K. The length of the ADS pump may vary between LAW and HLW with the depth and configuration of the feed vessels. See Appendix A and Appendix B for length requirements

L. Deleted

M. Feed slurry characteristics and glass forming chemicals are contained in Appendix A for LAW compositions and Appendix B for HLW composition.

N. Experience with previous ADS pump designs shall be considered to provide the best available design and technology.

O. Deleted

3.6 Materials

A. Materials selected shall be able to withstand the erosive and corrosive environment caused by the feed slurries for the design life cycle as defined in Section 3.3.D and that of the vessel it attaches to. Feed vessel material type for both HLW and LAW is ASME A240 type 316, (Appendix A and Appendix B). Erosion, corrosion and wear allowances shall be provided.

B. At a minimum, subcontractor shall evaluate the following corrosion and wear characteristics during material selection:

1. Surface finish
2. Chemical resistance
3. Radiation resistance
4. Pressure effects (cyclical)
5. Temperature effects
6. Hardness

7. Fatigue

C. Galling resistant material shall be used for pivot and sliding points.

3.7 Utility Services

A. Contractor will provide the following services to the ADS pumps: instrument air, process air, and demineralized water per Appendix A and Appendix B.

B. Deleted.

3.8 Maintenance Requirements

A. The HLW ADS pump, pump vent valve assembly, and pump actuator assembly shall be designed for remote replacement and removal. The LAW ADS pump, pump vent valve assembly, and pump actuator assembly shall be designed for hands-on maintenance.

B. The ADS pumps shall be designed for removal via an overhead crane. The pumps shall be designed to avoid snagging on the vessel flange during pump removal.

C. Indication of position shall be provided for the pump vent valve assembly to assist in troubleshooting of the assembly.

4 Quality Assurance Requirements

4.1 General

A. Subcontractor QAP requirements are included in Reference 2.2I. The Subcontractors QAP Manual shall be submitted to the Contractor for review per Reference 2.2I.

B. Subcontractor shall be responsible for all sub-tier vendor quality assurance requirements during design.

C. The ADS pumps are considered commercial grade components but shall be designed to the requirements of References 2.1F and 2.1G

D. The contractor reserves the right to review design work in progress to assess the effectiveness of the Subcontractors quality system at any time during the design process. Assessments performed by the Contractor shall in no way relieve the Subcontractor of any contractual responsibilities.

5 Documentation and Submittals

5.1 General

See Reference 2.2G for submittal format, transmission, and review requirements.

5.2 Submittals

See Reference 2.2G for specific ADS pump submittal requirements.

Appendix A – LAW ADS Pump Design Interface Details

Tag	Interface Detail	Interface Criteria	Interfacing System	Comments
lflg01	flange I.D. - vessel	12" diameter	LFP	standard 12", 150# ASME, flat face
lflg02	flange O.D. - vessel	19" diameter	LFP	standard 12", 150# ASME, flat face
lflg03	flange bolt circle - vessel	17" diameter	LFP	standard 12", 150# ASME, flat face
lflg04	flange bolt size - vessel	7/8" diameter	LFP	standard 12", 150# ASME, flat face
lflg05	flange bolt orientation - vessel	4 bolts, 90 degrees apart radially	LFP	standard 12", 150# ASME, flat face
lflg06	flange guide pin - size	7/8" diameter	LFP	
lflg07	flange guide pin – number/location/orientation	2 pins, 180 degrees apart on flg03 bolt circle	LFP	
lflg08	flange sealing requirements	O-ring, EPDM material, captive, underside flange	LFP	
lflg09	flange-vessel design pressure/temperature	15 psig (positive), full vacuum (negative), 150°F	LFP	
lflg10	flange-vessel operating pressure and temperature	0.07 psig (positive), -4.09 psig (negative), 98°F	LFP	
lflg11	flange-vessel material	SA240 316	LFP	pump material shall be compatible
lpmp01	pump length from top of vessel flange	12'-11"	LFP	
lpmp02	lifting bail requirements	pump – folding actuator – fixed vent valve - fixed	LFP	
lpmp03	deflection limits-distance from agitator to pump center to center	4'-6"	LFP	deflection limits will be based on agitator blade width and pump diameter, use lpmp03 and lpmp04
lpmp04	agitator speed/rotation/dia.	115 rpm/CW/36" dia (max)	LFP	final speed and configuration to be verified
lprc01	utility service quality – air, water	-instrument air to Reference 2.1E -process air is instrument air quality to -40°F dewpoint -demineralized water to 3.0μmho/cm conductivity	ISA PSA DIW	
lprc02	feed/waste properties	Reference 2.2K and 2.2L	LFP	

Appendix B – HLW ADS Pump Design Interface Details

Tag	Interface Detail	Interface Criteria	Interfacing System	Comments
hflg01	flange I.D. - vessel	12.75" diameter	HFP	
hflg02	flange O.D. - vessel	24.75" diameter	HFP	
hflg03	flange bolt circle - vessel	21.75" diameter	HFP	
hflg04	flange bolt size - vessel	1.25" diameter, with 2-7/8" retainer cups	HFP	
hflg05	flange bolt orientation - vessel	3 bolt, 120 degrees apart	HFP	
hflg06	flange guide pin - size	1.75" diameter	HFP	
hflg07	flange guide pin – number/location/orientation	2, 180° apart, same bolt circle as flg03	HFP	
hflg08	flange sealing requirements	remotely replaceable seal plate, rubber gasket	HFP	will be supplied with the vessel, not the ADS pumps
hflg09	flange-vessel design pressure/temperature	15 psig (positive), full vacuum (negative), 158°F	HFP	
hflg10	flange-vessel operating pressure/temperature	atmospheric to –0.104 psig, 131°F	HFP	
hflg11	flange-vessel material	SA240 316	HFP	pump flange material to be compatible
hflg12	torque-impact wrench	450 ft-lbs	HFP	
hpmp01	pump length from top of vessel flange	range: 12'-2" 13'-3"	HFP	
hpmp02	lifting bail requirements	pump – folding actuator – fixed vent valve - fixed	HFP	
hpmp03	deflection limits-distance from agitator to pump center to center	3'-3"	HFP	deflection limits will be based agitator blade width and pump diameter, use hpmp03 and hpmp04
hpmp04	agitator speed/rotation/dia	115 rpm/CW/36" dia (max)	HFP	assume same data for HLW as LAW, final speed and configuration to be verified
hpmp05	connectors	Staubli	HFP	vent valve, air actuator, air/water line, size as required for flow
hprc01	utility service quality – air, water	-instrument air to ISA S7.0.01 -process air is instrument air quality to -40°F dewpoint -demineralized water to 3.0µmho/cm	ISA PSA DIW	

		conductivity		
hprc02	feed/waste properties	Reference 2.2K and 2.2M	HFP	